

WHAT IS CLAIMED IS:

1. A method of authenticating a signature, comprising the steps of:  
sampling a signature and storing data representative of the signature;  
converting said data to high dimension vectors using a recursive sampling  
5 process;  
feeding the high dimension vectors to an unsupervised neural network and  
performing a high order principal component extraction process on the high  
dimension vectors by cumulative orthonormalization, thereby identifying clusters of  
high dimension points; and  
10 analyzing the clusters of high dimension points to determine, based on  
previously stored information, the authenticity of the signature.
2. The method of claim 1, further comprising the step of digitally  
sampling the signature;  
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3. The method of claim 1, wherein the sampling is effected via at least  
one of a mouse, a pressure sensitive pad, a digital tablet, a stylus and an electronic  
pen.
- 20 4. The method of claim 1, further comprising generating a list of  
time/location pairs.
5. The method of claim 3, further comprising sampling pressure applied  
to the at least one of the mouse, pressure sensitive pad, digital tablet, stylus and  
25 electronic pen.
6. The method of claim 1, wherein sampling is effected at a rate of at  
least about 40 samples per second.
- 30 7. The method of claim 1, wherein the recursive sampling process  
comprises iteratively focusing on increasingly smaller features of said signature,  
defined by shorter time spans.

8. The method of claim 7, wherein the recursive sampling process comprises 12 iterations.

5 9. The method of claim 7, wherein at time period associated with each iteration is in accordance with the following criteria:

(a) the time period examined in the first iteration is between 50% and 70% of a signature time (with steps of 2%);

(b) the time period examined in a second to 13<sup>th</sup> iterations is 70% of the  
10 time period examined in the previous iteration; and

(c) the time period in each iteration is either in the start of the time period of the previous iteration, or in its end, but not in the middle.

10. The method of claim 1, wherein the recursive sampling process lasts  
15 no more than 3 seconds.

11. The method of claim 1, wherein a neuron is prevented from growing to an extent whereby that neuron recognizes all vectors as a belonging to a single cluster.

20 12. The method of claim 1, wherein the clusters are circular or bubble-shaped.

13. The method of claim 12, wherein a radius of a bubble corresponds to the standard deviation of the distance of the vectors for a winning neuron.

14. The method of claim 1, the previously stored information generated by:

providing a plurality of sample signatures;

5 effecting the sampling, converting and feeding steps for each of the signatures;

computing a temporal summation  $r$  and an average temporal summation  $s$  for each of the signatures; and

based on the computed  $r$  and  $s$  values, outputting a measure of global signature structure deviation  $A$  and a measure of local signature structure deviation  $B$ .

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15. The method of claim 14, wherein  $r$  is a ratio of the number of vectors within an ellipsoid to the total number of vectors and  $s$  is the average of distances of all vectors within the ellipsoid.

16. The method of claim 14, wherein the previously stored information is compared with the signature to determine, based on a predetermined criteria, the authenticity thereof.

17. The method of claim 14, further comprising multiplying values  $A$  and  
20  $B$  including and determining whether the product is less than 1.

18. The method of claim 17, further comprising executing the multiplying step in a Pi neuron.

25 19. The method of claim 18, wherein 20 to 40 Pi neurons are employed.

20. The method of claim 1, further comprising assessing the presence of overgeneralization in said neural network.

21. The method of claim 20, wherein a condition of overgeneralization is deemed to occur when at least one of a ratio of the number of vectors within an ellipsoid to the total number of vectors squared ( $r^2$ ) and an average of distances of all  
5 vectors within the ellipsoid squared ( $s^2$ ) divided by the variance of the value  $r$  or  $s$ , respectively, is greater than a predetermined threshold.

22. A system for authenticating a signature, comprising:  
sampling means for sampling a signature and storing data representative of the  
signature;

5 converting means, connected downstream of the sampling means, for  
converting the data to high dimension vectors;

an unsupervised neural network for receiving the high dimension and  
performing a high order principal component extraction process on the high  
dimensions vectors, thereby identifying clusters of high dimension points; and

10 analyzing means, connected to the unsupervised neural network, for analyzing  
the clusters of high dimension points to determine, based on previously stored  
information, the authenticity of the signature;

23. The system of claim 22, wherein the sampling means comprises at  
15 least one of a mouse, a pressure sensitive paid, a digital tablet, a stylus and an  
electronic pen.

24. The system of claim 22, further comprising Pi neurons, at least one of  
which is a multiplication Pi neuron.

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25. The system of claim 22, wherein the system is incorporated in a  
personal computer.

26. The system of claim 25, wherein the personal computer is connected to  
25 the Internet.

27. The system of claim 22, wherein the signature is provided as  
identification information for at least one of a legal transaction, financial transaction  
and biometric verification.

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